

Evolution and Life's Diversity

Ch. 13 and 14



Evolution: *the process by which modern organisms have descended from ancient organisms*

Darwin's Dilemma

- Full name: Charles Robert Darwin
- His voyage:
 - 22 years old at departure
 - Vessel name: Beagle



- Route taken:



- What he did during the voyage:
 - Went ashore and collected animal and plant species

On board he:

- Got sea sick
- Examined his specimens
- Filled his notebooks with his thoughts and observations
- Spent many hours reading the most current scientific books

The Diversity of Life

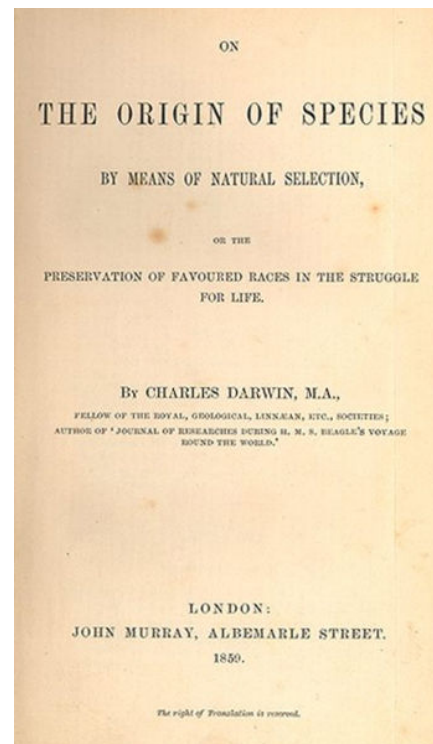
- Biodiversity: the variety of living things
- Why was travel a significant contributing factor to Darwin's work?
 - He saw countless of different living things
- Current estimates of the number of living species range from 3 million to 20 million
- 99.9% of species that lived on Earth at some time are now extinct

III. Fitness: To survive and Reproduce

Fitness: the physical traits and behaviours that enable organisms to survive and reproduce in their environment

Darwin's book: *The Origin of Species by Means of Natural Selection*

Published: 1859



- In it he argues that : *just as with each new organism comes from preexisting organisms, each species has descended from other species over time. If you look back far enough in time, you will see that all species have shared or common ancestors.*
- **This principle is called *common descent***

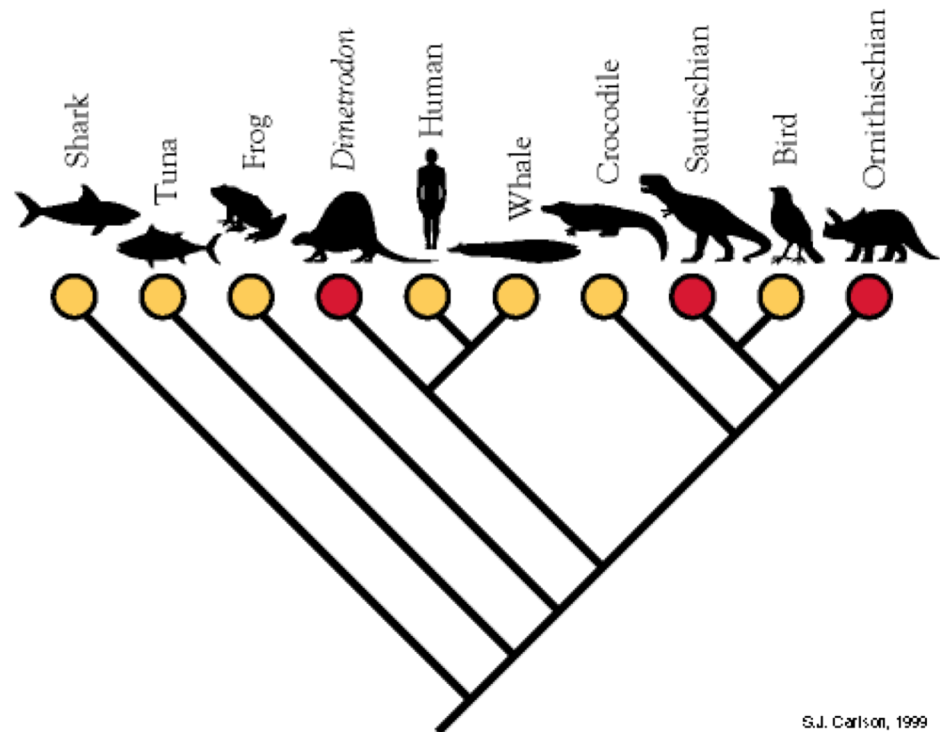


Figure 4. Cladogram illustrating phylogenetic relationships among ten familiar kinds of animals, interested in nine clades denoted by the nine nodes. Open circles denote living taxa; filled circles denote extinct taxa. The common names and Linnean binomials of the terminal taxa are: shark (*Carcharodon carcharias*); tuna (*Thunnus albacares*); frog (*Rana pipiens*); fin-backed pelycosaure (*Dimetrodon grandis*); human (*Homo sapiens*); whale (*Ballænoptera musculus*); crocodile (*Crocodytus acutus*); saurischian dinosaur (*Tyrannosaurus rex*); bird (*Melospiza melodea*); ornithischian dinosaur (*Triceratops homidus*). Redrawn from Carlson, 1995.

S.J. Carlson, 1999

- Darwin also says that fitness arises through **adaptation**
- **Adaptation**: any inherited characteristic that increases an animal's or plant's fitness for survival



Amazing adaptation One of the extraordinary adaptations which evolution generates in the extreme Antarctic cold is found in the ice fish. It has evolved to have no red blood cells and no haemoglobin, meaning that its blood flows more freely. The oxygen which its muscles need simply dissolves in the blood. *(Image: J Gutt, Alfred Wegener Institute)*

13-2 Age of the Earth

Evidence in stone

Past beliefs:

- Age: a few thousand years
- Features (mountians, valleys, etc)
produced by sudden catastrophic events that
humans rarely witnessed and could not
understand

- Evidence that the Earth was old began to accumulate...

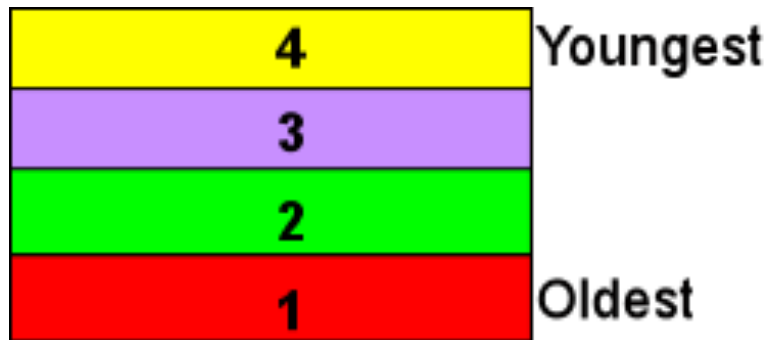
Scientist:	Year:	What they said:
James Hutton	1788	Rocks, mountains and valleys had been changed gradually by rain, heat, cold, the activity of volcanoes, and other natural forces. These processes operate slowly so the Earth had to be much more than a few thousand years old.
Charles Lyell	1830	That scientists must always explain past events in terms of events and processes they could observe themselves because that was the only way the scientific method could work
Professional and amateur geologists	N/A	<p>a) Found fossils (def'n): (do yourself)</p> <p>b) Some did not resemble species on Earth today, such as:</p>

II. The geologic Time Scale: A clock in the rocks

Lower rocks were deposited before upper layers and therefore had to be older (Law of Superposition)

Therefore fossils found in lower layers are older than those found above

Relative dating relies on the position of one fossil compared to another



Radioactive Dating

- Uses radioactive elements in rock that decay at a known rate. These are called radioactive elements
- 1. ^{238}U turns into ^{206}Pb w/ half-life of 4.5 billion yrs
- 2. ^{40}K turns into ^{40}Ar w/ half-life of 1.3 billion yrs
- 3. ^{14}C turns into ^{14}N w/ half-life of 5770 yrs

Q: Which system would be the best choice to date:

- A rock sample thought to be 3.5 billion years old?
- A wooden post thought to be 20000 years old?
- Uranium
- Carbon

Absolute dating

- Method of measuring rates of decay of radioactive materials to determine how long ago an event occurred or an organism lived.
- Current estimate of the Earth's age: 4.5 billion years old.

The Fossils Form

- In cold places, animals sometimes fell into crevasses in ice or became trapped in snow fields

The six-month-old female calf was discovered on the Yamal peninsula of Russia and is thought to have died 10,000 years ago. The animal's trunk and eyes are still intact and some of its fur remains on the body.



How fossils form:

- In tree sap, insects and other small animals were occasionally trapped



- When animals got stuck in peat bogs, quicksand or tar pits

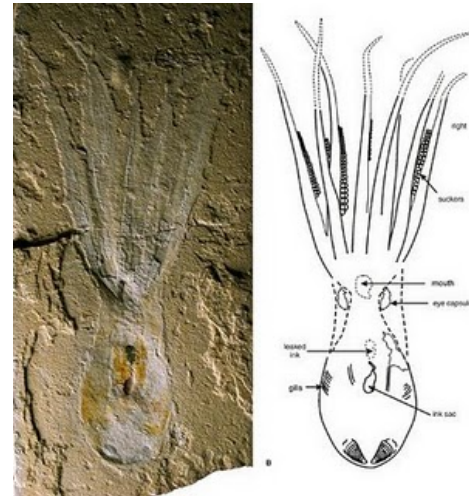


- Most are formed in sedimentary rock when small particles as well as dead organisms are deposited to lake or ocean bottoms



- Pressure turns loose sediments into rock by the upper layers compressing the lower layers

- A record is made of soft body parts by: small particles of rock that buried plant or animal remains



- A record is made of hard body parts by replacing the wood, shells, or bones with long lasting mineral compounds - petrified





II. Fossil Evidence: Problems in assembling the puzzle

- **What is the significance of “chance” with respect to the fossil record?**
- The significance of chance by which organisms are fossilized means that the fossil record is not as complete as we would like it to be.
- For every organism that leaves a proper fossil, many die and vanish without leaving a trace

- **Name an organism that has a very low chance of forming a fossil, and explain why?**
- A soft bodied organism that lives on land because the soft bodies don't preserve as well and living on land tends to be harder to become a fossil

- Fossils can be exposed when exposed by weathering of the rock around it
- The quality of fossil preservation varies as well as the completeness of the sample



What the Fossil Record Tells Us

- The fossil record represents: ***the preserved collective history of Earth's organisms***
- It also tells of major changes in Earth's ***climate*** and ***geography***
 - Fossilized shark teeth have been found in Arizona indicating that the deserts of the American Southwest were once covered by ancient seas.
 - Giant fossil ferns found in Canada show that N. America once had a much warmer tropical climate



- A consequence of this is that species die out!



13-4 Evidence From Living Organisms

1. Similarities in Early Development

- Embryo: *organism at an early stage of development*
- 19th C. scientists noticed *the embryos of many different animals looked so different that it was difficult to tell them apart*

Human Embryo



Cat Embryo

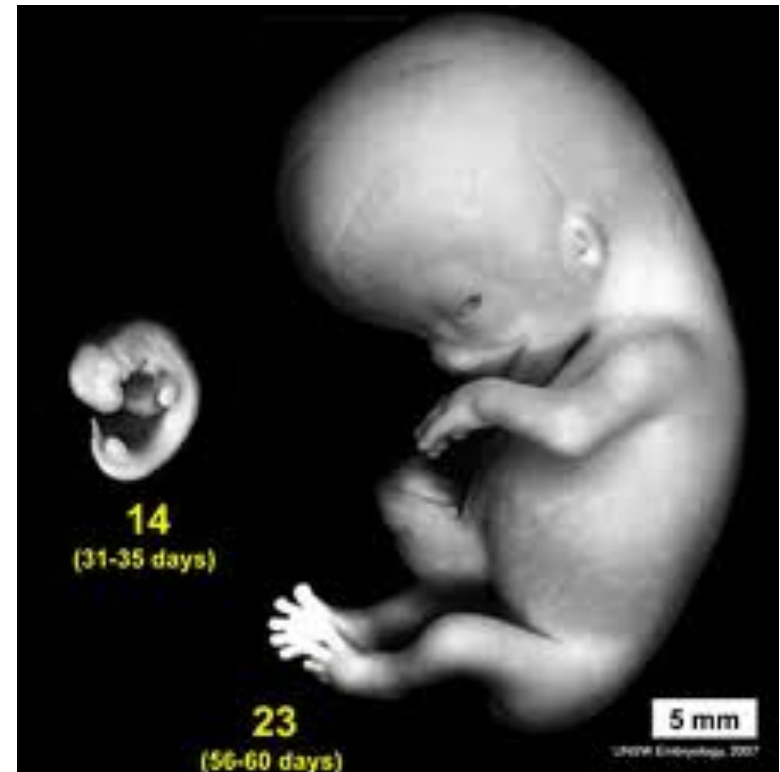


Mouse Embryo



- Similarities in early development indicate that similar genes are at work
- These genes came from a **common ancestor**

As the embryos (of different species)
grow and develop, they become
more dissimilar



- The changes in genes are caused by ***mutations***, or changes in the genetic blueprint contained within an organisms DNA

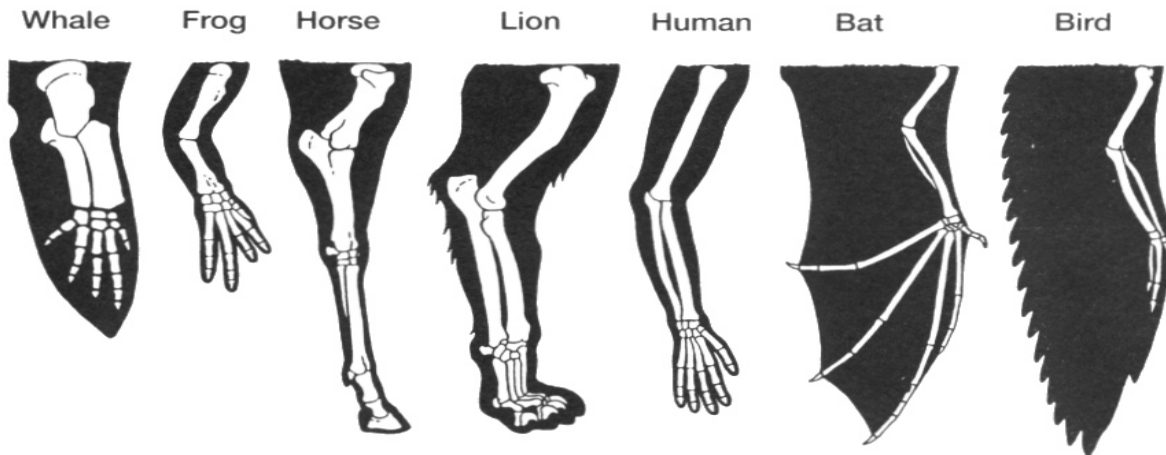
Q: What happens to an organism with an “early” mutation?

Mutations that affect early stages of development are likely to be lethal. An organism carrying such a mutation dies while it is and its genes are not passed on

- Later mutations tend to be less drastic and may be potentially useful!
- Organisms with this kind of mutation may survive to reproduce and pass the changes in its DNA to its offspring

Similarities in Body Structure

Homologous Structures: *parts of different organisms, often quite dissimilar, that developed from the same ancestral body parts*



Fill in chart Fig 13-17 fill in the chart

Vestigial organs: *a structure that serves no useful purpose in an organism*

1. *Snake: have tiny bones that are the remnants of legs*

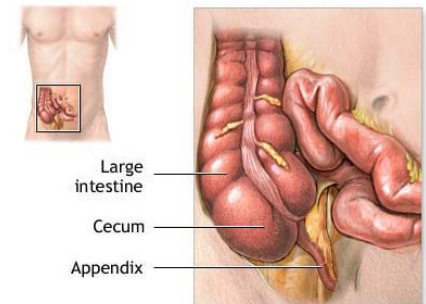
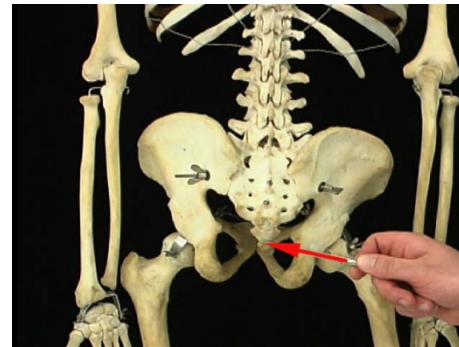


2. *Human:*

1. *Have a set of miniature tailbones at the base of our spine*

2. *Ear muscles*

3. *Appendix: probably used in the digestion of food*



Similarities in Chemical Compounds

- All organisms use the following chemicals:
 - DNA and RNA to carry information
 - ATP to carry energy
- The more closely related two species are, the more closely their important chemical compounds resemble each other.

What Homologies Tell Us

- Similarities provide evidence that all living things evolved from common ancestors
- The best explanation for them is that living organisms evolved through gradual modification of earlier forms – descent from a common ancestor